Claims

[1] A bake-hardenable high-strength cold-rolled steel sheet manufactured through hot rolling, cold rolling and continuous annealing of a steel , comprising: 0.0016 ~ 0.01 % of C; 0.1 % or less of Si; 0.2 ~ 1.5 % of Mn; 0.05 ~ 0.15 % of P; 0.01 % or less of S; 0.08 ~ 0.5 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.1 % of Nb; 0.01 ~ 0.4 % of Mo; 0.0005 ~ 0.005 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates formed upon hot rolling the steel, and a grain size(ASTM No.) of 9 or more, the fine AlN precipitates having a size acting as a barrier for suppressing grain growth during annealing of the steel sheet.

[2] The steel sheet according to claim 1, wherein Al content is greater than 0.1 % and equal to or less than 0.5 %.

[3] The steel sheet according to claim 1 or 2, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[4] The steel sheet according to claim 1 or 2, wherein the AlN precipitates have an average size of 20 □ or less.

[5] The steel sheet according to claim 3, wherein the AlN precipitates have an average size of 20 □ or less.

[6] The steel sheet according to claim 1 or 2, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[7] The steel sheet according to claim 3, wherein the steel sheet further comprises NbC precipitates having an average grain size of 30 nm or less.

[8] The steel sheet according to claim 4, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[9] The steel sheet according to claim 5, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[10] A bake-hardenable high-strength cold-rolled steel sheet manufactured through hot rolling, cold rolling and continuous annealing of a steel, comprising: 0.0016 ~ 0.01 % of C; 0.1 % or less of Si; 0.2 ~ 1.5 % of Mn; 0.05 ~ 0.15 % of P; 0.01 % or less of S; 0.08 ~ 0.5 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.1 % of Nb; 0.003 % or less of Ti; 0.01 ~ 0.4 % of Mo; 0.0005 ~ 0.005 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates formed upon hot rolling the steel, and a grain size(ASTM No.) of 9 or more, the fine AlN precipitates having a size acting as a barrier for

suppressing grain growth during annealing of the steel sheet.

[11] The steel sheet according to claim 10, wherein Al content is greater than 0.1 % and equal to or less than 0.5 %.

[12] The steel sheet according to claim 10 or 11, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[13] The steel sheet according to claim 10 or 11, wherein the AlN precipitates have an average size of 20 □ or less.

[14] The steel sheet according to claim 12, wherein the AlN precipitates have an average size of 20 □ or less.

[15] The steel sheet according to claim 10 or 11, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[16] The steel sheet according to claim 12, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[17] The steel sheet according to claim 13, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[18] The steel sheet according to claim 14, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[19] A bake-hardenable high-strength cold-rolled steel sheet, comprising:
0.0016 ~ 0.0025 % of C; 0.02 % or less of Si; 0.2 ~ 1.2 % of Mn; 0.05 ~ 0.11 % of P; 0.01 % or less of S; 0.08 ~ 0.12 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.011 % of Nb; 0.01 ~ 0.1 % of Mo; 0.0005 ~ 0.0015 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates having a grain size of 20 □ or less, a grain size(ASTM No.) of 9 or more, a bake hardening (BH) value of 30 MPa or more, an aging index (AI) of 30 MPa or less, a DBTT of -30 °C or less at a drawing ratio of 2.0, and a tensile strength of 340 ~ 390 MPa.

[20] The steel sheet according to claim 19, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[21] A bake-hardenable high-strength cold-rolled steel sheet, comprising:
0.0016 ~ 0.0025 % of C; 0.02 % or less of Si; 0.2 ~ 1.2 % of Mn; 0.05 ~ 0.11 % of P; 0.01 % or less of S; 0.08 ~ 0.12 % of (soluble) Al; 0.0025 % or less of N; 0.003 % or less of Ti; 0.003 ~ 0.011 % of Nb; 0.01 ~ 0.1 % of Mo; 0.0005 ~ 0.0015 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7,
wherein the steel sheet has fine AlN precipitates having a grain size of 20 □ or

less, a grain size(ASTM No.) of 9 or more, a bake hardening (BH) value of 30 MPa or more, an aging index (AI) of 30 MPa or less, a DBTT of -30 ℃ or less at a drawing ratio of 2.0, and a tensile strength of 340 ~ 390 MPa.

[22] The steel sheet according to claim 21, wherein the steel sheet comprises greater amounts of solute carbon in a grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[23] A hot-dipped steel sheet manufactured through hot rolling, cold rolling, continuous annealing, hot dipping, and temper rolling of a steel, comprising: 0.0016 ~ 0.01 % of C; 0.1 % or less of Si; 0.2 ~ 1.5 % of Mn; 0.05 ~ 0.15 % of P; 0.01 % or less of S; 0.08 ~ 0.5 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.1 % of Nb; 0.01 ~ 0.4 % of Mo; 0.0005 ~ 0.005 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight% while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates formed upon hot rolling the steel, and a grain size(ASTM No.) of 9 or more, the fine AlN precipitates having a size acting as a barrier for suppressing grain growth during annealing of the steel sheet.

[24] The steel sheet according to claim 23, wherein Al content is greater than 0.1 % and equal to or less than 0.5 %.

[25] The steel sheet according to claim 23 or 24, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[26] The steel sheet according to claim 23 or 24, wherein the AlN precipitates have an average size of 20 □ or less.

[27] The steel sheet according to claim 25, wherein the AlN precipitates have an average size of 20 □ or less.

[28] The steel sheet according to claim 23 or 24, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[29] The steel sheet according to claim 25, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[30] The steel sheet according to claim 26, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[31] The steel sheet according to claim 27, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[32] A hot-dipped steel sheet manufactured through hot rolling, cold rolling, continuous annealing, hot dipping, and temper rolling of a steel, comprising: 0.0016 ~ 0.01 % of C; 0.1 % or less of Si; 0.2 ~ 1.5 % of Mn; 0.05 ~ 0.15 % of P; 0.01 % or less of S; 0.08 ~ 0.5 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.1 % of Nb; 0.003 % or less of Ti; 0.01 ~ 0.4 % of Mo; 0.0005 ~ 0.005 % of

B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates formed upon hot rolling the steel, and a grain size(ASTM No.) of 9 or more, the fine AlN precipitates having a size acting as a barrier for suppressing grain growth during annealing of the steel sheet.

[33] The steel sheet according to claim 32, wherein Al content is greater than 0.1 % and equal to or less than 0.5 %.

[34] The steel sheet according to claim 32 or 33, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[35] The steel sheet according to claim 32 or 33, wherein the AlN precipitates have an average size of 20 □ or less.

[36] The steel sheet according to claim 34, wherein the AlN precipitates have an average size of 20 □ or less.

[37] The steel sheet according to claim 32 or 33, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[38] The steel sheet according to claim 34, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[39] The steel sheet according to claim 35, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[40] The steel sheet according to claim 36, wherein the steel sheet further comprises NbC precipitates having an average size of 30 nm or less.

[41] A hot-dipped steel sheet, comprising:
0.0016 ~ 0.0025 % of C; 0.02 % or less of Si; 0.2 ~ 1.2 % of Mn; 0.05 ~ 0.11 % of P; 0.01 % or less of S; 0.08 ~ 0.12 % of (soluble) Al; 0.0025 % or less of N; 0.003 ~ 0.011 % of Nb; 0.01 ~ 0.1 % of Mo; 0.0005 ~ 0.0015 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7, wherein the steel sheet has fine AlN precipitates having a grain size of 20 □ or less, a grain size(ASTM No.) of 9 or more, a bake hardening (BH) value of 30 MPa or more, an aging index (AI) of 30 MPa or less, a DBTT of -30 °C or less at a drawing ratio of 2.0, and a tensile strength of 340 ~ 390 MPa.

[42] The steel sheet according to claim 41, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[43] A hot-dipped steel sheet, comprising:
0.0016 ~ 0.0025 % of C; 0.02 % or less of Si; 0.2 ~ 1.2 % of Mn; 0.05 ~ 0.11 % of P; 0.01 % or less of S; 0.08 ~ 0.12 % of (soluble) Al; 0.0025 % or less of N;

0.003 % or less of Ti; 0.003 ~ 0.011 % of Nb; 0.01 ~ 0.1 % of Mo; 0.0005 ~ 0.0015 % of B; and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7,
wherein the steel sheet has fine AlN precipitates having a grain size of 20 □ or less, a grain size (ASTM No.) of 9 or more, a bake hardening (BH) value of 30 MPa or more, an aging index (AI) of 30 MPa or less, a DBTT of -30 °C or less at a drawing ratio of 2.0, and a tensile strength of 340 ~ 390 MPa.

[44] The steel sheet according to claim 43, wherein the steel sheet comprises greater amounts of solute carbon in the grain boundary than in grain, and the amount of solute carbon in grain is in the range of 3 ~ 6 ppm.

[45] A method for manufacturing a bake-hardenable high-strength cold-rolled steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at or above an Ar_3 transformation temperature to provide a hot rolled steel sheet after heating the steel slab to a temperature of 1,200 °C or more, the steel slab comprising 0.0016 ~ 0.01 % of C, 0.1 % or less of Si, 0.2 ~ 1.5 % of Mn, 0.05 ~ 0.15 % of P, 0.01 % or less of S, 0.08 ~ 0.5 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.1 % of Nb, 0.01 ~ 0.4 % of Mo, 0.0005 ~ 0.005 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet;
cold rolling the hot-rolled steel sheet; and
continuous annealing the cold-rolled steel sheet.

[46] A method for manufacturing a bake-hardenable high-strength cold-rolled steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at or above an Ar_3 transformation temperature to provide a hot rolled steel sheet after heating the steel slab to a temperature of 1,200 °C or more, the steel slab comprising 0.0016 ~ 0.01 % of C, 0.1 % or less of Si, 0.2 ~ 1.5 % of Mn, 0.05 ~ 0.15 % of P, 0.01 % or less of S, 0.08 ~ 0.5 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.1 % of Nb, 0.003 % or less of Ti, 0.01 ~ 0.4 % of Mo, 0.0005 ~ 0.005 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet;
cold rolling the hot-rolled steel sheet; and
continuous annealing the cold-rolled steel sheet.

[47] A method of manufacturing a bake-hardenable high-strength cold-rolled steel sheet, comprising the steps of:

hot-rolling a steel slab with finish rolling at a temperature of 900 ~ 950 °C to provide a hot rolled steel sheet, after homogenizing the steel slab at a temperature of 1,200 °C or more, the steel slab comprising 0.0016 ~ 0.0025 % of C, 0.02 % or less of Si, 0.2 ~ 1.2 % of Mn, 0.05 ~ 0.11 % of P, 0.01 % or less of S, 0.08 ~ 0.12 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.011 % of Nb, 0.01 ~ 0.1 % of Mo, 0.0005 ~ 0.0015 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet at a temperature of 600 ~ 650 °C;
cold rolling the hot-rolled steel sheet at a reduction rate of 75 ~ 80 %; and
continuous annealing the cold-rolled steel sheet at a temperature of 770 ~ 830 °C.

[48] A method of manufacturing a bake-hardenable high-strength cold-rolled steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at a temperature of 900 ~ 950 °C to provide a hot rolled steel sheet, after homogenizing the steel slab at a temperature of 1,200 °C or more, the steel slab comprising 0.0016 ~ 0.0025 % of C, 0.02 % or less of Si, 0.2 ~ 1.2 % of Mn, 0.05 ~ 0.11 % of P, 0.01 % or less of S, 0.08 ~ 0.12 % of (soluble) Al, 0.0025 % or less of N, 0.003 % or less of Ti, 0.003 ~ 0.011 % of Nb, 0.01 ~ 0.1 % of Mo, 0.0005 ~ 0.0015 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet at a temperature of 600 ~ 650 °C;
cold rolling the hot-rolled steel sheet at a reduction rate of 75 ~ 80 %; and
continuous annealing the cold-rolled steel sheet at a temperature of 770 ~ 830 °C.

[49] A method for manufacturing a hot-dipped steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at or above an Ar_3 transformation temperature to provide a hot rolled steel sheet after heating the steel slab to a temperature of 1,200 °C or more, the steel slab comprising 0.0016 ~ 0.01 % of C, 0.1 % or less of Si, 0.2 ~ 1.5 % of Mn, 0.05 ~ 0.15 % of P, 0.01 % or less of S, 0.08 ~ 0.5 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.1 % of Nb, 0.01 ~ 0.4 % of Mo, 0.0005 ~ 0.005 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet;
cold rolling the hot-rolled steel sheet;
continuous annealing the cold-rolled steel sheet;
hot dipping the annealed steel sheet; and
temper rolling the hot-dipped steel sheet.

[50] A method for manufacturing a hot-dipped steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at or above an Ar_3 transformation temperature to provide a hot rolled steel sheet after heating the steel slab to a temperature of 1,200 ℃ or more, the steel slab comprising 0.0016 ~ 0.01 % of C, 0.1 % or less of Si, 0.2 ~ 1.5 % of Mn, 0.05 ~ 0.15 % of P, 0.01 % or less of S, 0.08 ~ 0.5 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.1 % of Nb, 0.003 % or less of Ti, 0.01 ~ 0.4 % of Mo, 0.0005 ~ 0.005 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet;
cold rolling the hot-rolled steel sheet;
continuous annealing the cold-rolled steel sheet;
hot dipping the annealed steel sheet; and
temper rolling the hot-dipped steel sheet.

[51] A method for manufacturing a hot-dipped steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at a temperature of 900 ~ 950 ℃ to provide a hot rolled steel sheet, after homogenizing the steel slab at a temperature of 1,200 ℃ or more, the steel slab comprising 0.0016 ~ 0.0025 % of C, 0.02 % or less of Si, 0.2 ~ 1.2 % of Mn, 0.05 ~ 0.11 % of P, 0.01 % or less of S, 0.08 ~ 0.12 % of (soluble) Al, 0.0025 % or less of N, 0.003 ~ 0.011 % of Nb, 0.01 ~ 0.1 % of Mo, 0.0005 ~ 0.0015 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet at a temperature of 600 ~ 650 ℃;
cold rolling the hot-rolled steel sheet at a reduction rate of 75 ~ 80 %;
continuous annealing the cold-rolled steel sheet at a temperature of 770 ~ 830 ℃;
hot dipping the annealed steel sheet; and
temper rolling the hot-dipped steel sheet at a reduction rate of 1.2 ~ 1.5 %.

[52] A method for manufacturing a hot-dipped steel sheet, comprising the steps of:
hot-rolling a steel slab with finish rolling at a temperature of 900 ~ 950 ℃ to provide a hot rolled steel sheet, after homogenizing the steel slab at a temperature of 1,200 ℃ or more, the steel slab comprising 0.0016 ~ 0.0025 % of C, 0.02 % or less of Si, 0.2 ~ 1.2 % of Mn, 0.05 ~ 0.11 % of P, 0.01 % or less of S, 0.08 ~ 0.12 % of (soluble) Al, 0.0025 % or less of N, 0.003 % or less of Ti, 0.003 ~ 0.011 % of Nb, 0.01 ~ 0.1 % of Mo, 0.0005 ~ 0.0015 % of B, and the balance of Fe and other unavoidable impurities, in terms of weight%, while satisfying an Nb/C ratio of 0.3 ~ 0.7;
coiling the hot-rolled steel sheet at a temperature of 600 ~ 650 ℃;

cold rolling the hot-rolled steel sheet at a reduction rate of 75 ~ 80 %;
continuous annealing the cold-rolled steel sheet at a temperature of 770 ~ 830 ℃;
hot dipping the annealed steel sheet; and
temper rolling the hot-dipped steel sheet at a reduction rate of 1.2 ~ 1.5 %.